Measurement in SI and imperial slide deck

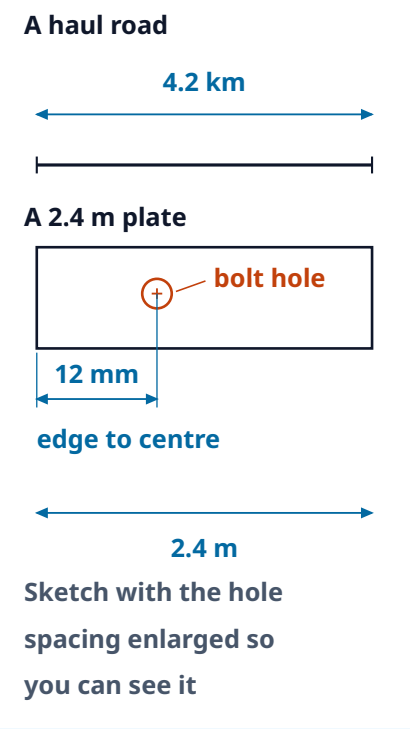
Mathematics 10-3

Unit M: Measurement in SI and imperial

SI prefixes and base units

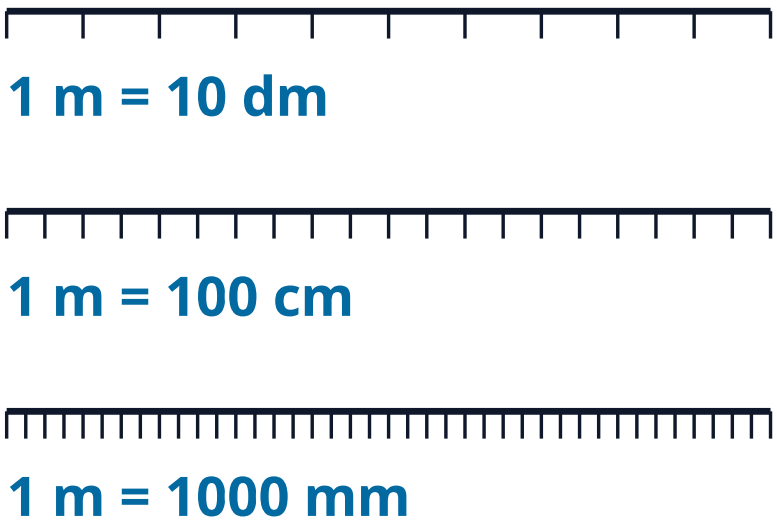
Prefixes in daily use

- A truck log says 4.2 kilometres.
- A shop drawing says the plate is 2.4 metres, with a bolt hole whose centre is 12 millimetres from the edge.
- A clinic label uses milligrams.
- Those jobs all use SI.
- Kilo means 1000.
- Milli means one thousandth.
- The prefix tells you which size of unit you have.



Base units and the six prefixes

- You measure a room in metres, flour in kilograms, and a jug in litres.
- A floor uses square metres.
- A box uses cubic metres.
- Milli means 0.001, centi means 0.01, and deci means 0.1.
- Deca means 10 and its symbol is da.
- Hecto means 100.
- Kilo means 1000.
- The mark 10^{-3} means 10 to the power of −3, which equals 0.001.
- That is why milli lines up with a three-place decimal.



Key terms

SI prefix

A base-ten marker written before a unit to scale it. This course uses milli, centi, deci, deca, hecto, and kilo. (m, c, d, da, h, k)

metre

The SI base unit of length. Other length units in this course are prefixes on the metre. (m)

kilogram

The SI base unit of mass. The name already includes kilo, and a gram is one thousandth of a kilogram. (kg)

litre

The capacity unit on SI job sheets. One litre equals one cubic decimetre. (L)

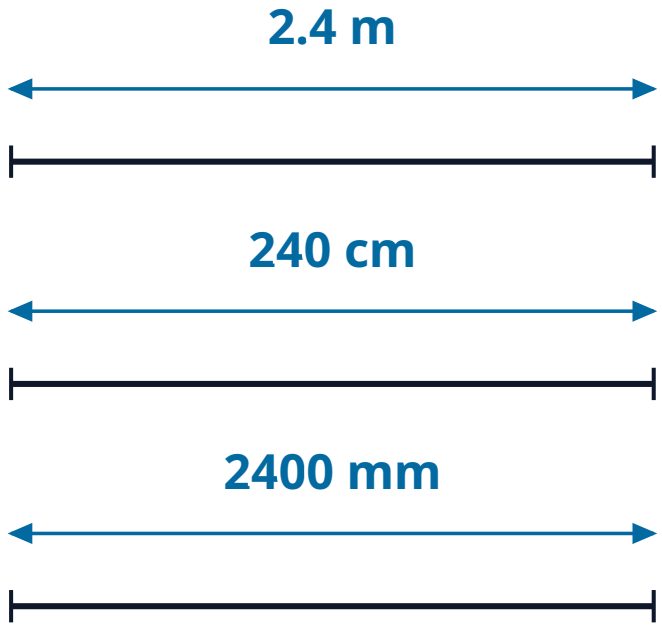
Key terms

kelvin

The SI base unit of temperature. A change of one kelvin equals a change of one degree Celsius. (K)

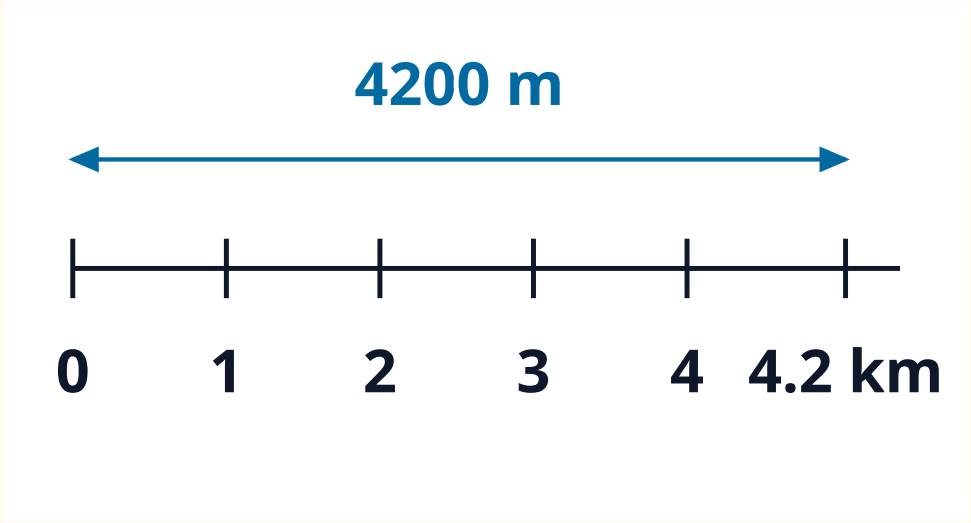
Prefix conversions

- Centimetres are smaller than metres, so multiply by 100.
- Multiplying 2.4 by 100 equals 240 centimetres.
- Millimetres are smaller still, so multiply by 1000.
- Multiplying 2.4 by 1000 equals 2400 millimetres.
- The offset of 12 millimetres, from the plate edge to the bolt-hole centre, divided by 1000 equals 0.012 metres.
- Kilo means 1000, so 4.2 times 1000 equals 4200 metres.



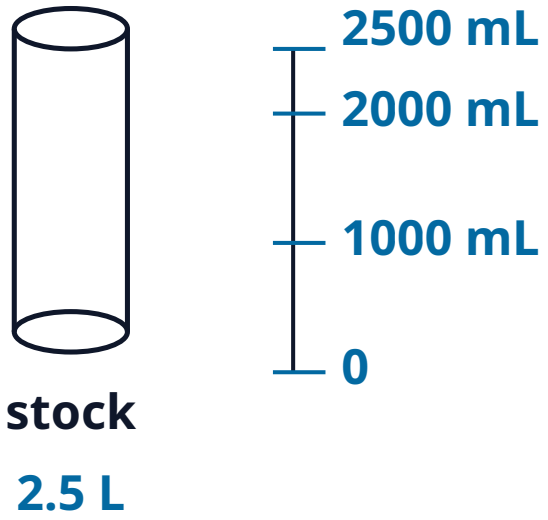
A haul of 4.2 kilometres in metres

- The symbol km stands for kilometre, and the symbol m stands for metre.
- Kilo means 1000, so the haul in metres is 4.2 times 1000.
- Multiplying 4.2 by 1000 equals 4200, so the haul is 4200 metres.



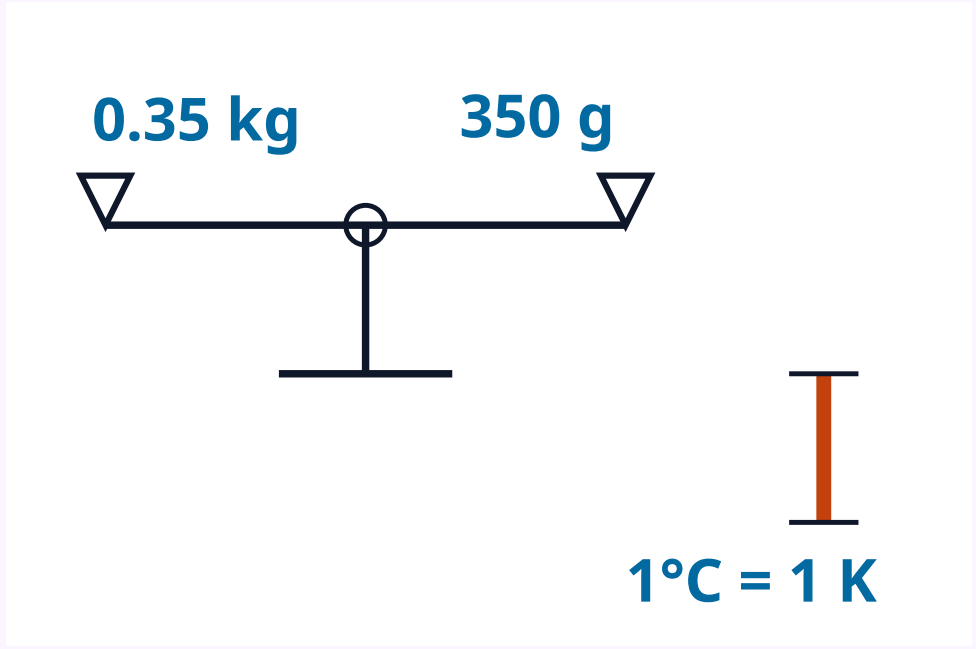
Soup stock in millilitres

- The symbol L stands for litre and the symbol mL stands for millilitre.
- Milli means 0.001, so one litre equals 1000 millilitres.
- Multiplying 2.5 litres by 1000 equals 2500 millilitres of stock.



Mass prefixes and kelvin

- The kilogram already includes the prefix kilo, so a gram is one thousandth of a kilogram and 0.35 kilograms equals 350 grams.
- A 250 milligram tablet equals 0.25 grams because milli means one thousandth and 250 divided by 1000 equals 0.25.
- Job sheets record degrees Celsius, the kelvin is the temperature base unit, and a change of 1 degree Celsius equals a change of 1 kelvin.



Prefix check on the bench

- Rewrite 3.75 metres in centimetres and in millimetres before you leave the ladder.
- State the factor for kilo and use it on a mass or a distance you choose from the lesson.



Mathematics 10-3

Unit M: Measurement in SI and imperial

Imperial units and fractions

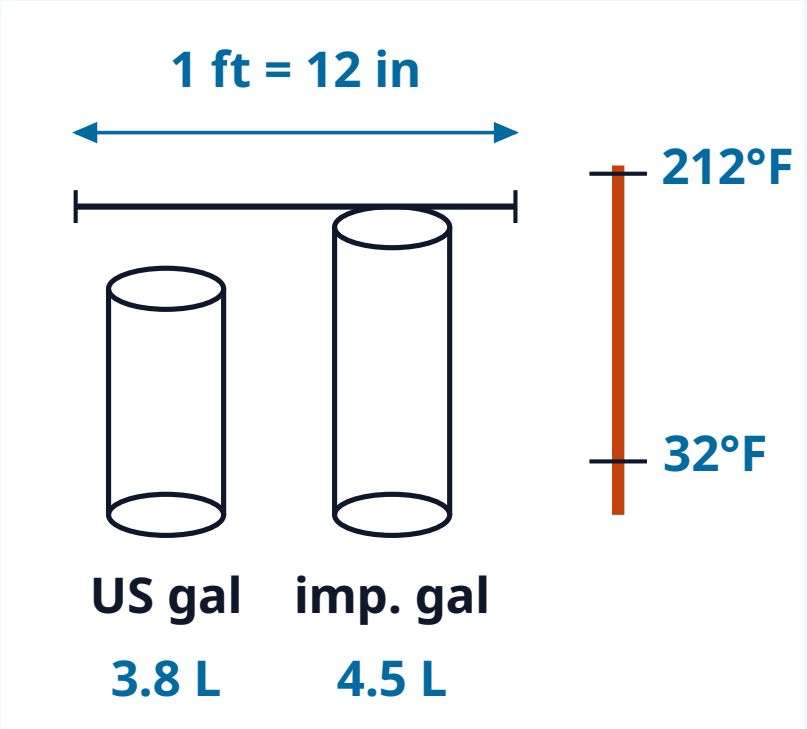
A tape that still speaks inches

- A framer’s tape, a plumbing fitting, and some aviation sheets in Canada still list feet and inches beside SI.
- These units come from older English trade measures.
- A tape splits each inch in half, then in half again: 1/2, 1/4, 1/8, and 1/16.



Imperial units

- One foot equals 12 inches, one yard equals 3 feet and also 36 inches, and one mile equals 1760 yards.
- A floor patch is measured in square feet.
- A box is measured in cubic inches.
- Nails and butter use ounces, and 16 ounces make 1 pound.
- A US gallon is about 3.8 litres, and a British imperial gallon is about 4.5 litres.
- Water freezes at 32 degrees Fahrenheit and boils at 212 degrees Fahrenheit.



Key terms

inch

A small imperial length. Twelve inches make one foot, and the inch is halved into fractions. (in)

foot

An imperial length equal to 12 inches. Three feet make one yard. (ft)

gallon

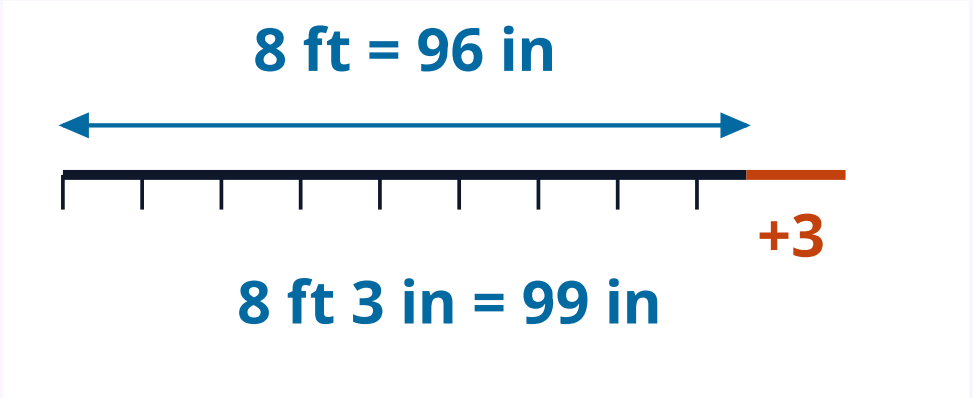
A capacity unit that comes in two trade sizes in this course: the US gallon and the British imperial gallon. (gal)

Fahrenheit

An imperial temperature scale. Water freezes at 32 degrees Fahrenheit and boils at 212. (F)

Feet and inches on the tape

- The symbol ft stands for feet and the symbol in stands for inches.
- Change feet and inches into inches by multiplying the feet by 12 and then adding the extra inches.
- A board of 8 feet 3 inches equals 99 inches, because 8 times 12 equals 96 and 96 plus 3 equals 99.



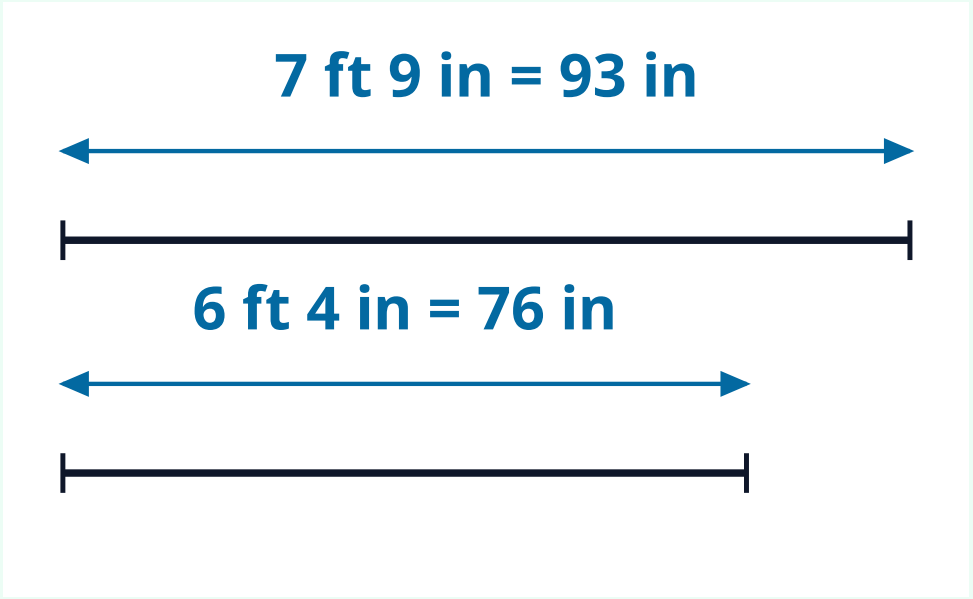
Inches back to feet

- An aviation hose is listed as 54 inches.
- Divide by 12 to find the feet, because one foot equals 12 inches.
- Four groups of 12 use 48 inches, and 54 minus 48 equals 6, so the hose is 4 feet 6 inches.



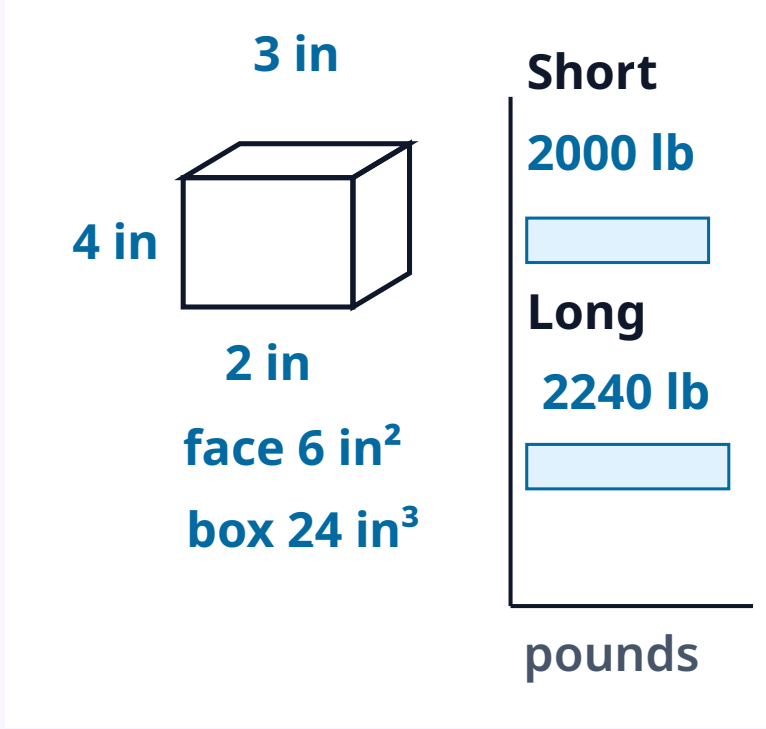
A plumbing run and a doorway

- A plumbing run of 7 feet 9 inches becomes inches when you multiply 7 by 12 and add 9.
- Seven times 12 equals 84, and 84 plus 9 equals 93 inches.
- A doorway height of 6 feet 4 inches equals 76 inches, because 6 times 12 equals 72 and 72 plus 4 equals 76.



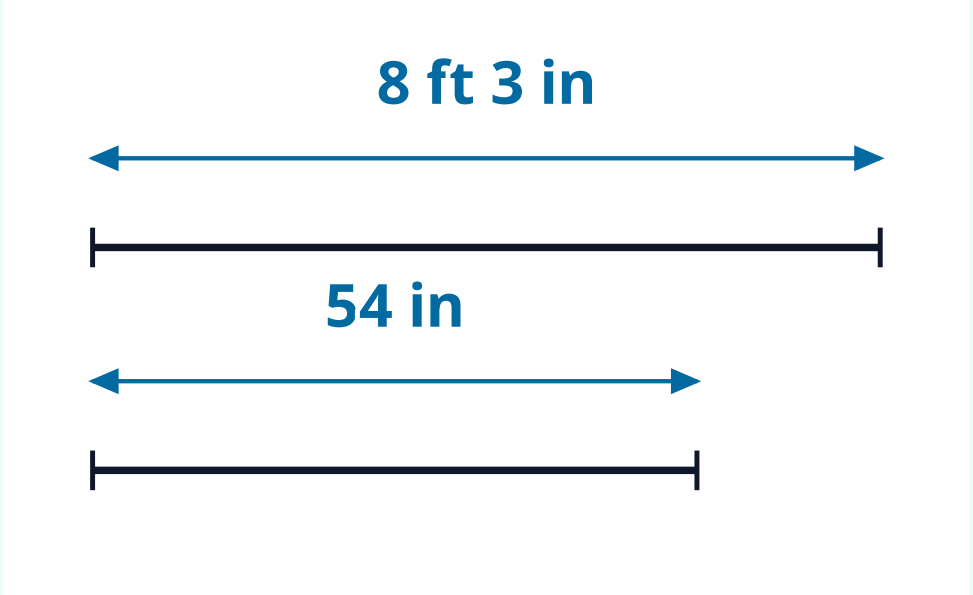
Imperial units of capacity and mass

- A US gallon holds about 3.8 litres and a British imperial gallon holds about 4.5 litres.
- A US short ton equals 2000 pounds and a British long ton equals 2240 pounds.
- A US bushel is about 35 litres and an imperial bushel is about 36 litres.
- One pound equals 16 ounces, so 2 times 16 equals 32 ounces.
- A face of 2 inches by 3 inches has area 2 times 3, which equals 6 square inches.
- A 2 by 3 by 4 box starts with 2 times 3, which equals 6, and 6 times 4 equals 24 cubic inches.



Tape and jug check

- Write 8 feet 3 inches as inches, and write 54 inches as feet and inches.
- State the litre size of a US gallon and of a British imperial gallon.



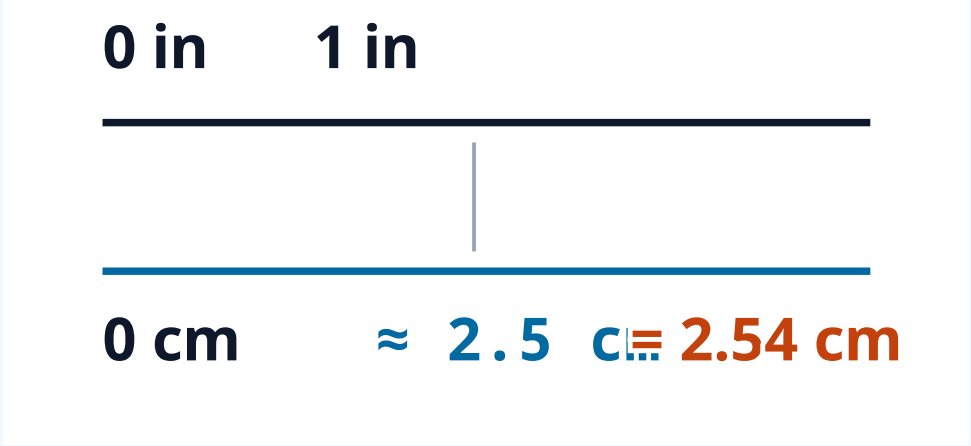
Mathematics 10-3

Unit M: Measurement in SI and imperial

SI and imperial conversion

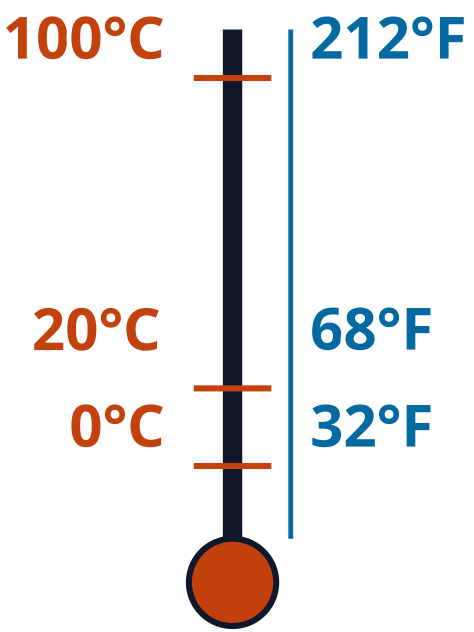
SI and imperial in daily use

- A cabinet drawing labels a stile in inches while the shop rule asks for centimetres, and a prep kitchen log records degrees Celsius.
- Every inch on that drawing uses the same centimetre rate.
- Every Celsius reading on the log uses the same Fahrenheit rule.



Rates that stay proportional

- One inch is approximately 2.5 centimetres as a referent, and a drawing that asks for the trade factor uses 1 inch equals 2.54 centimetres.
- F stands for degrees Fahrenheit and C stands for degrees Celsius.
- The formulas are F = (9/5)C + 32 and C = (5/9) times (F minus 32).
- One litre is approximately one quarter of a US gallon, so 8 litres is about 2 US gallons.



Key terms

centimetre

A hundredth of a metre. Trade drawings in this course use 2.54 centimetres for one inch. (cm)

Celsius

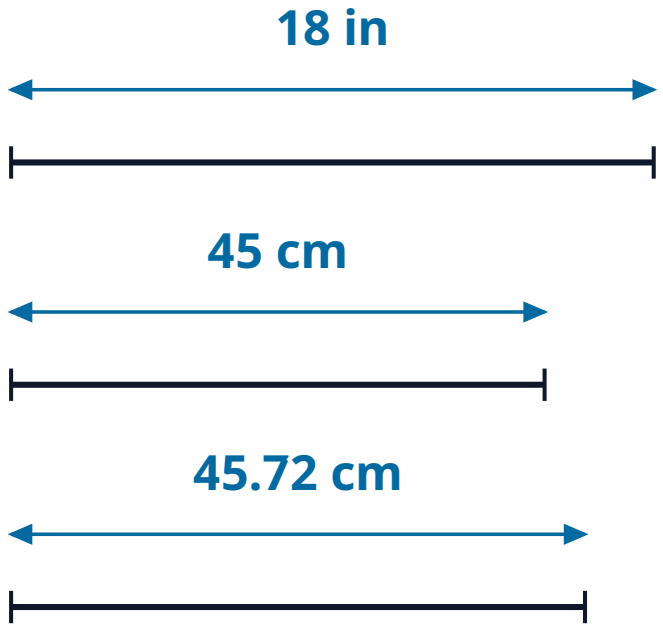
The job-sheet temperature scale. The letter C stands for degrees Celsius. (C)

Fahrenheit

The imperial temperature scale. The letter F stands for degrees Fahrenheit. (F)

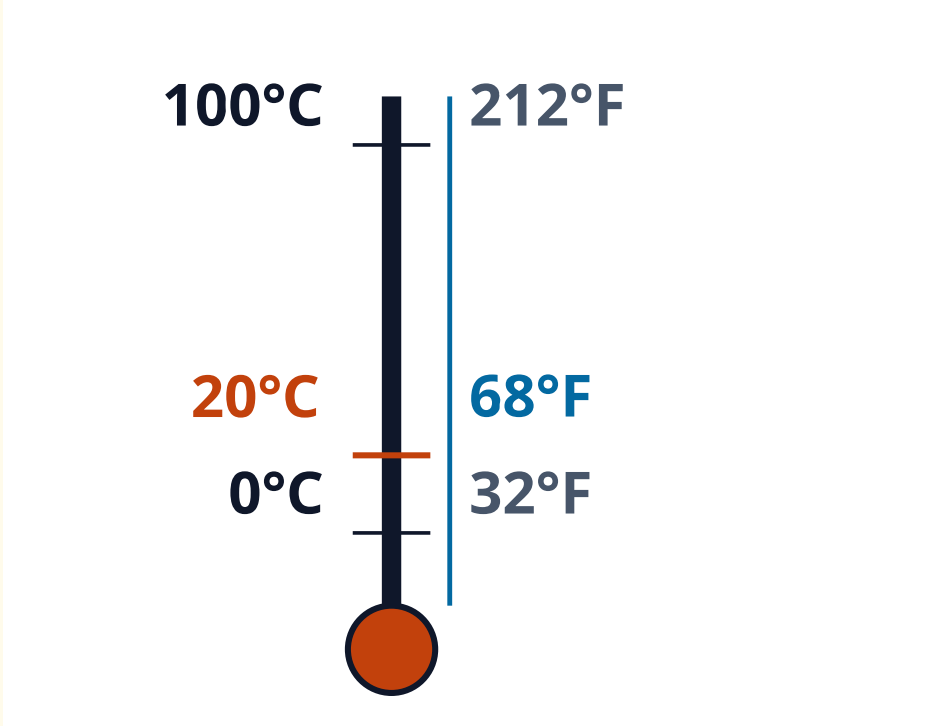
Estimates and exact conversions

- Eighteen inches times 2.5 gives the estimate 45 centimetres.
- Eighteen inches times 2.54 gives the trade length 45.72 centimetres.
- Four inches estimate to 10 centimetres and trade to 10.16 centimetres.
- Twelve inches estimate to 30 centimetres and trade to 30.48 centimetres.



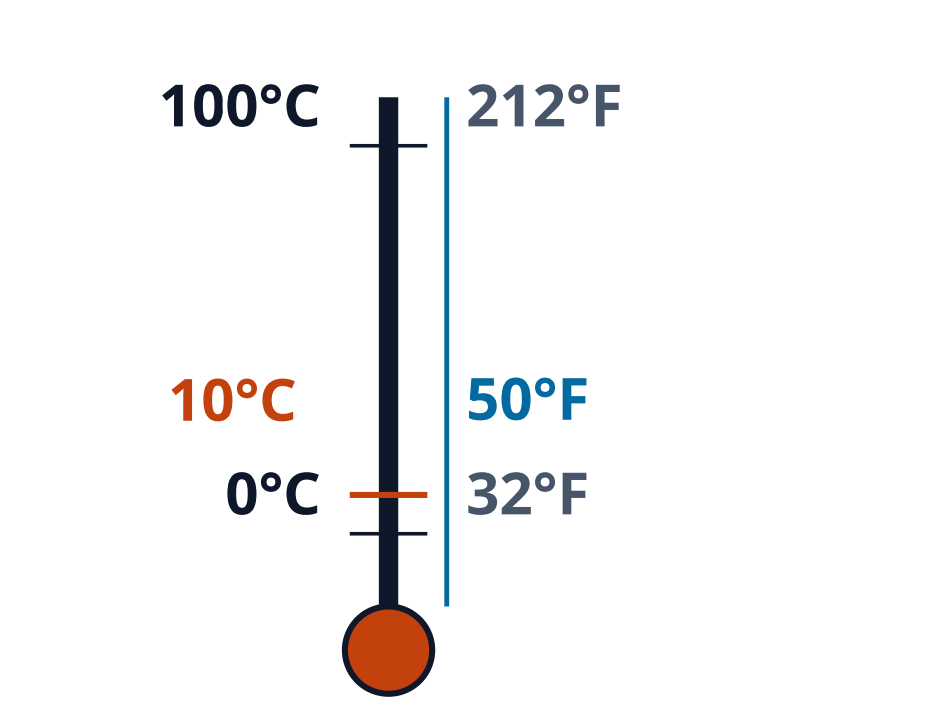
Twenty degrees Celsius to Fahrenheit

- The letter C stands for degrees Celsius and the letter F stands for degrees Fahrenheit.
- Multiply the Celsius reading by 9/5 first.
- That 20 times 9/5 equals 36.
- Then add 32.
- That 36 plus 32 equals 68, so 20 degrees Celsius equals 68 degrees Fahrenheit.



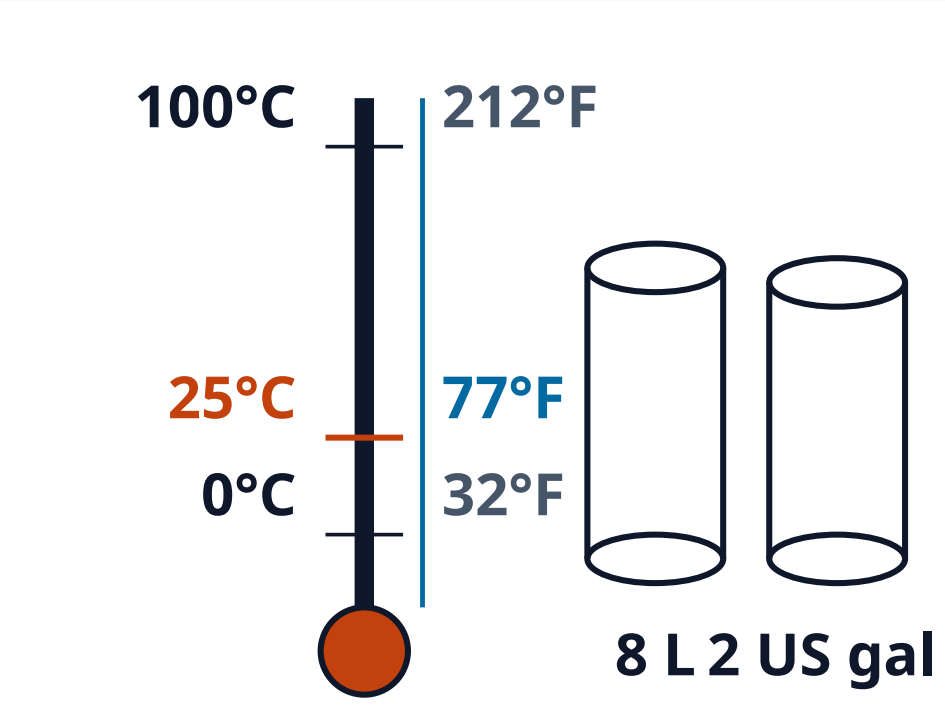
A cooler at 50 degrees Fahrenheit

- The reverse formula is C = (5/9) times (F minus 32).
- Subtract 32 from 50 first.
- That 50 minus 32 equals 18.
- Then multiply by 5/9.
- That 18 times 5/9 equals 10, so 50 degrees Fahrenheit equals 10 degrees Celsius.



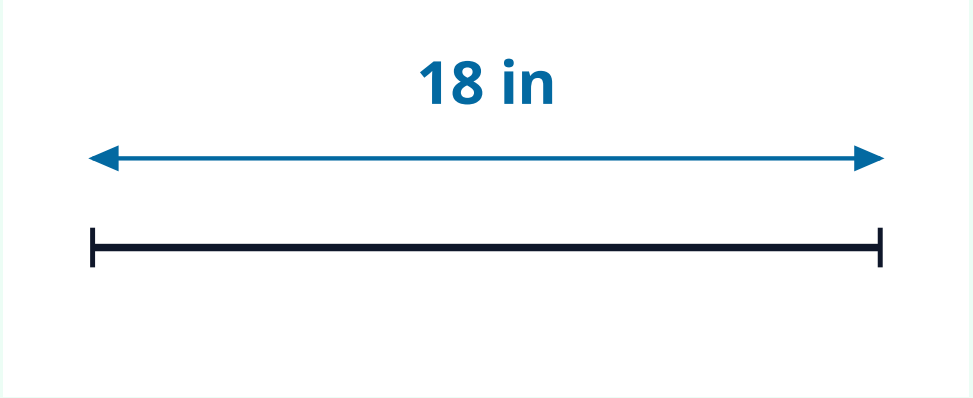
Seventy-seven Fahrenheit and a jug of stock

- A dial at 77 degrees Fahrenheit converts by subtracting 32 from 77 to leave 45, then multiplying 45 by 5/9 to reach 25 degrees Celsius.
- Eight litres is about 2 US gallons because 1 litre is approximately 1/4 US gallon and 8 times 1/4 equals 2.
- The estimate 2.5 centimetres per inch stays a picture.
- The printed factor 2.54 is the machining rate.



Rate check before the cut

- Give both the estimate and the trade centimetre length for 18 inches.
- Convert 20 degrees Celsius to Fahrenheit and show the multiply step before the add.



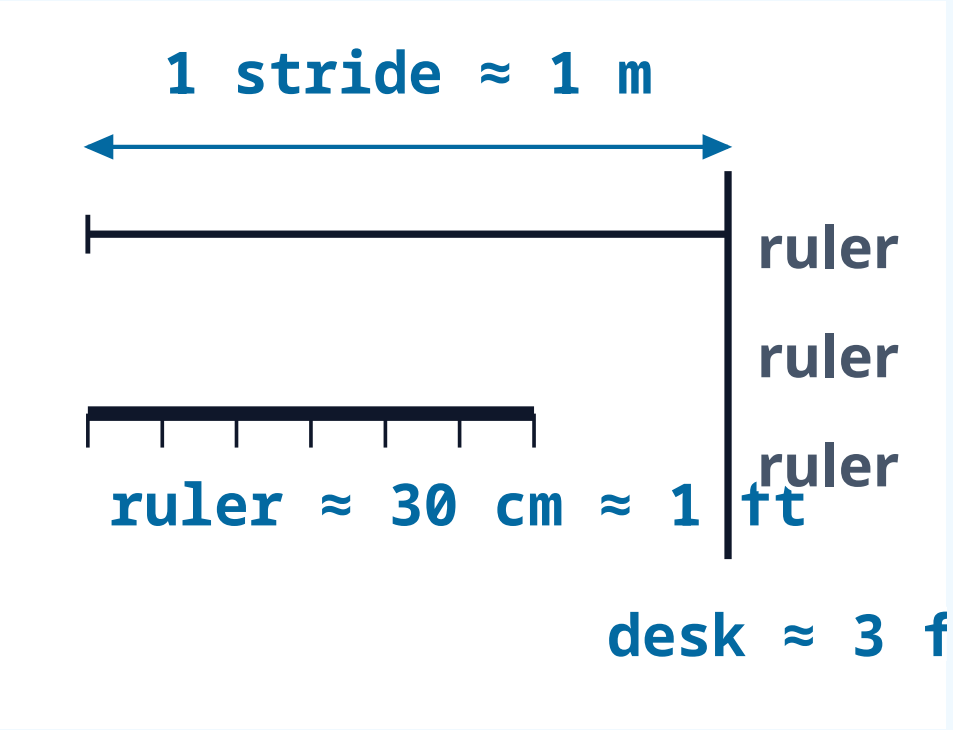
Mathematics 10-3

Unit M: Measurement in SI and imperial

Linear measurement on the job

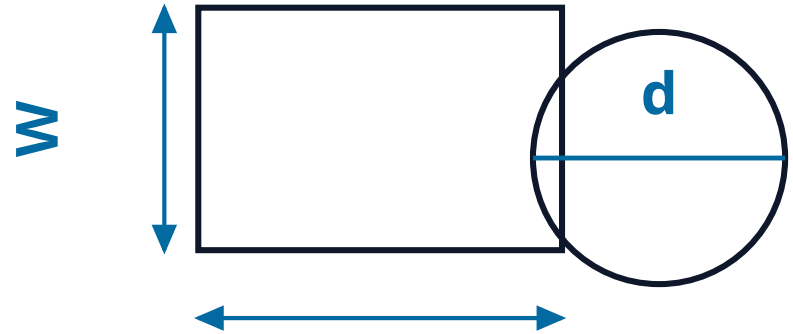
Measuring tools and referents

- A long stride is about 1 metre.
- A ruler is about 30 centimetres, which is also about 1 foot.
- A desk about three rulers tall is about three feet.
- A pipe fitter reads an outside diameter and an inside diameter before ordering a sleeve that has to match the wall.



Referents and perimeter formulas

- OD means outside diameter.
- ID means inside diameter.
- The pipe wall is half of OD minus ID.
- Perimeter walks the outline: P = 2(L + W).
- L is length and W is width.
- Around a circle, C = 3.14 times the diameter.
- C is circumference and 3.14 stands in for pi.
- A shipping size adds length, width, and height.
- The midpoint is half the board.
- Put the measured number in place of each letter.



Key terms

outside diameter

The distance across a pipe or tube measured on the outer surface. (OD)

inside diameter

The distance across the opening inside a pipe or tube. (ID)

perimeter

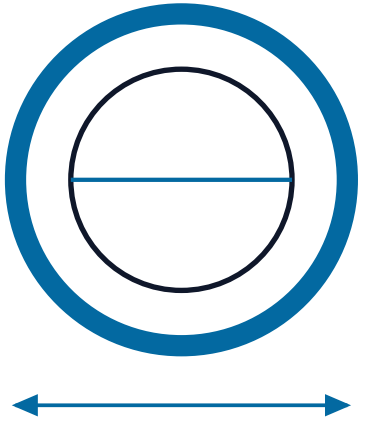
The distance around a flat shape. For a rectangle, P = 2(L + W). (P)

circumference

The distance around a circle. In this course C = pi d with pi taken as 3.14. (C)

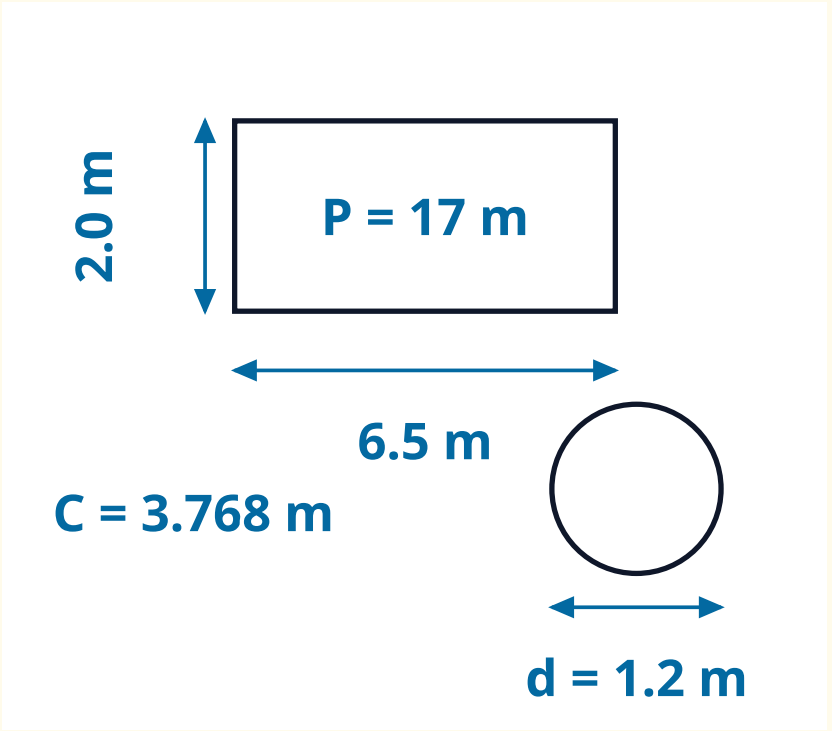
Half the diameter gap

- Outside 5.2 centimetres minus inside 4.6 centimetres equals a gap of 0.6 centimetres.
- Half of 0.6 is 0.3, so the wall thickness is 0.3 centimetres.
- Outside 26 millimetres minus inside 20 millimetres equals a gap of 6 millimetres.
- Half of 6 millimetres is a 3 millimetre wall.



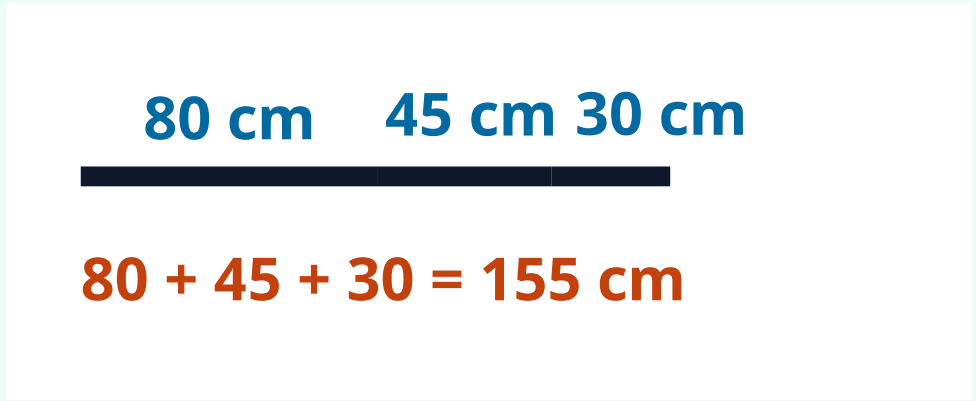
A mat outline and a round lid

- A mat 6.5 metres by 2.0 metres has P = 2(L + W).
- Add 6.5 plus 2.0 to get 8.5, then times 2 to get 17 metres.
- The letter C stands for circumference, d for diameter, and pi is 3.14.
- A diameter of 1.2 metres gives C = 3.14 times 1.2.
- Multiplying 3.14 by 1 equals 3.14 and 3.14 times 0.2 equals 0.628, so the circumference is 3.768 metres.
- A diameter of 0.5 metres gives 3.14 times 0.5 equals 1.57 metres.



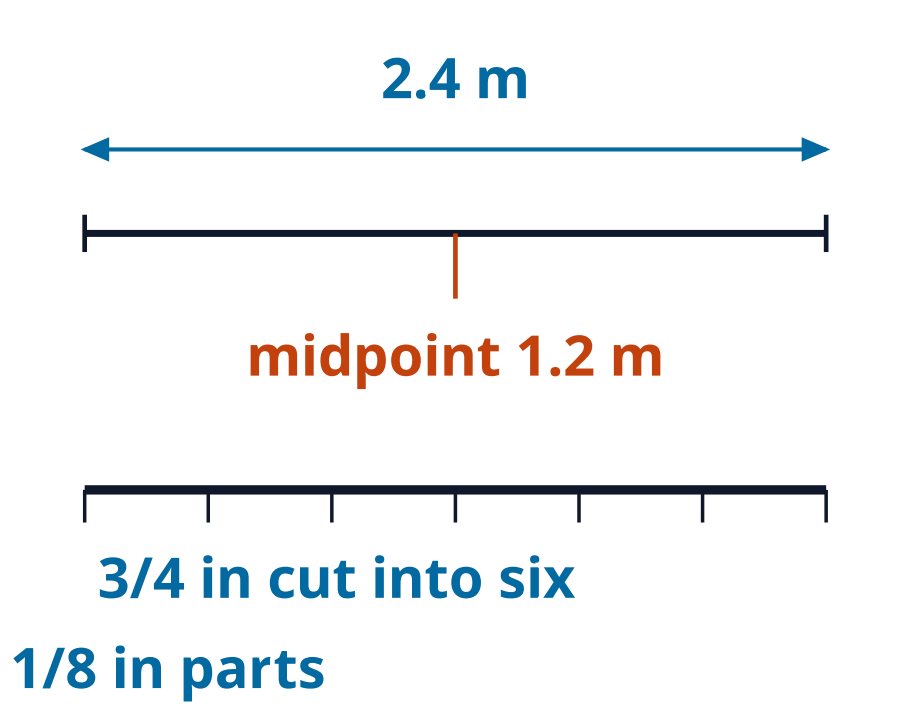
Shipping linear size

- The letters L, W, and H stand for length, width, and height in the shipping sum L + W + H.
- A carton of 80 centimetres, 45 centimetres, and 30 centimetres adds to 155 centimetres.
- A suitcase of 70, 40, and 25 centimetres adds to 135 centimetres, and 135 sits below a stated limit of 158 centimetres.



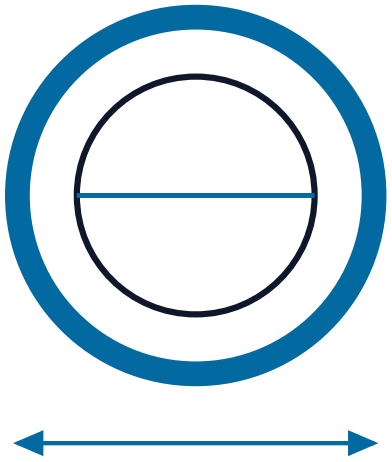
Midpoints and segments

- A midpoint is half the length.
- A 2.4 metre board marks at 1.2 metres, and a 94 inch board marks at 47 inches.
- Dividing 3/4 by 1/8 equals 6, because 3/4 times 8/1 equals 6, so a 3/4 inch strip yields six 1/8 inch segments.
- Adding joins lengths, multiplying counts repeated equal pieces, and dividing by 2 marks a midpoint.
- Compare the result with a referent.



Job-site linear check

- Find the wall for an outside diameter of 26 millimetres and an inside diameter of 20 millimetres.
- Find the perimeter of a 6.5 metre by 2.0 metre mat and say why the result is reasonable.



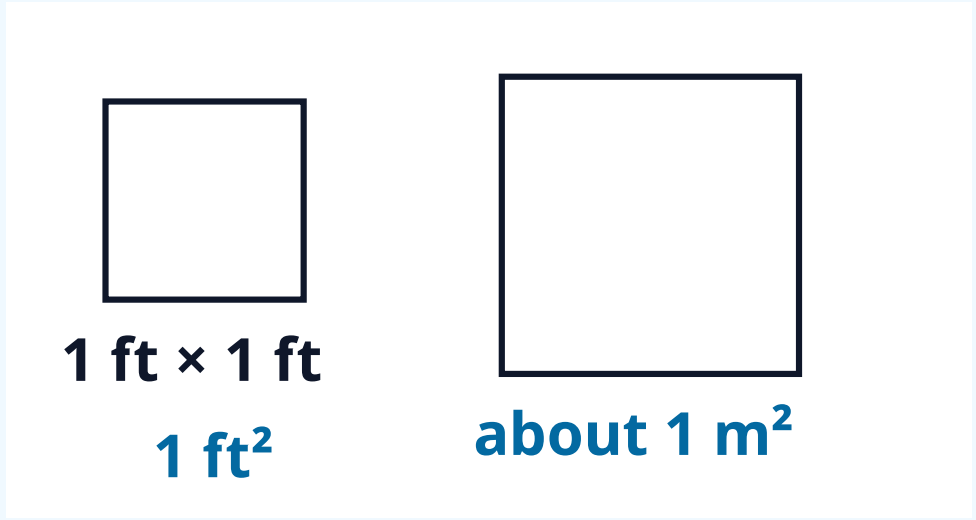
Mathematics 10-3

Unit M: Measurement in SI and imperial

Area of flat shapes

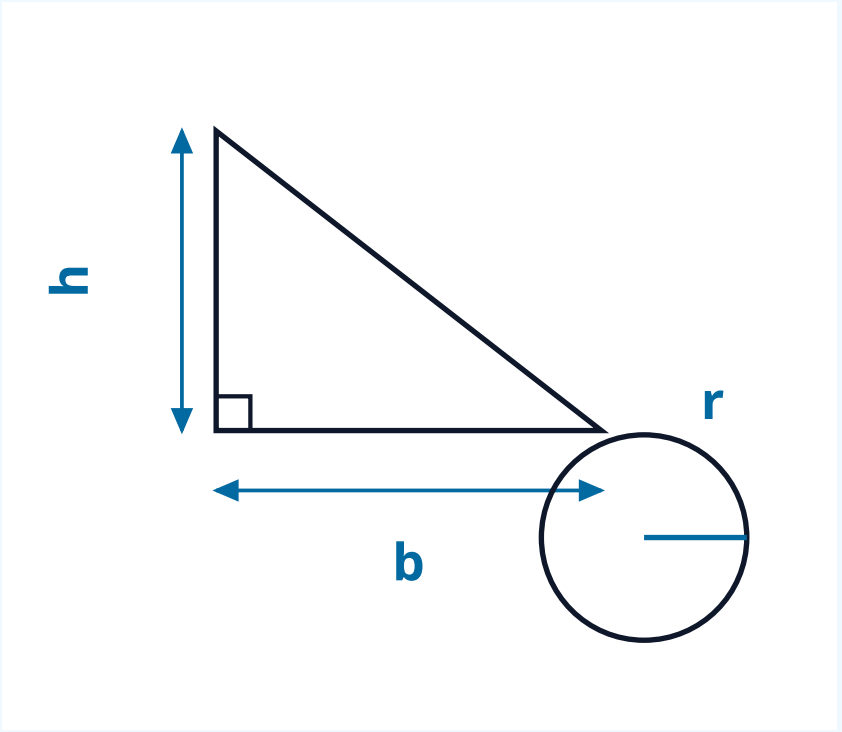
A floor tile and a desk top

- A floor tile 1 foot by 1 foot covers 1 square foot, and a desk top can cover about 1 square metre.
- A painter and a flooring installer both price work from area, so a wild square count wastes material.



Formulas for flat cover

- A rectangle’s area is length times width.
- A means area, l means length, and w means width, so A = l w.
- A triangle’s area is half of base times height.
- The letter b is the base and the letter h is the height.
- For a circle, r is the radius, half the diameter, and A = $3.14r^2$.
- Split an L-shaped room into two rectangles, then add the areas.
- One square metre equals 10 000 square centimetres.



Key terms

square metre

The SI unit of area. A square one metre on each side, written m2. (m2)

radius

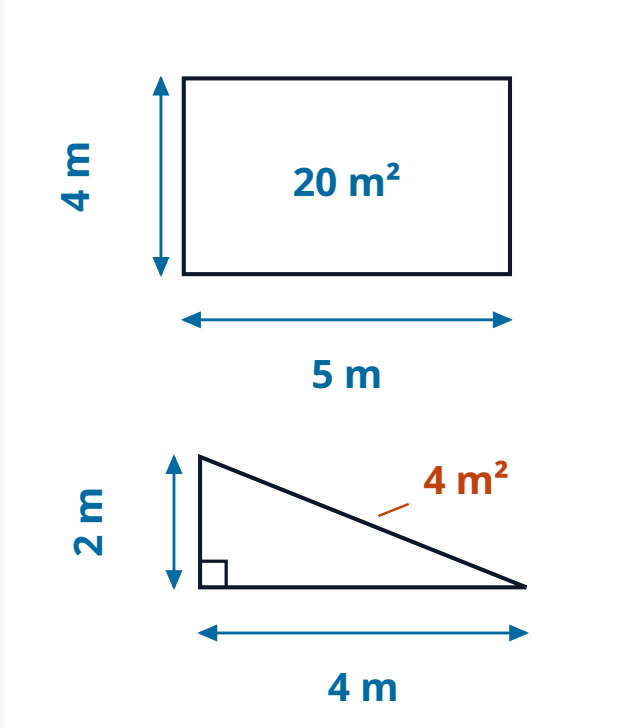
The distance from the centre of a circle to the rim. The radius is half the diameter. (r)

base

The side of a triangle used with the height in the area formula A = (1/2) b h. (b)

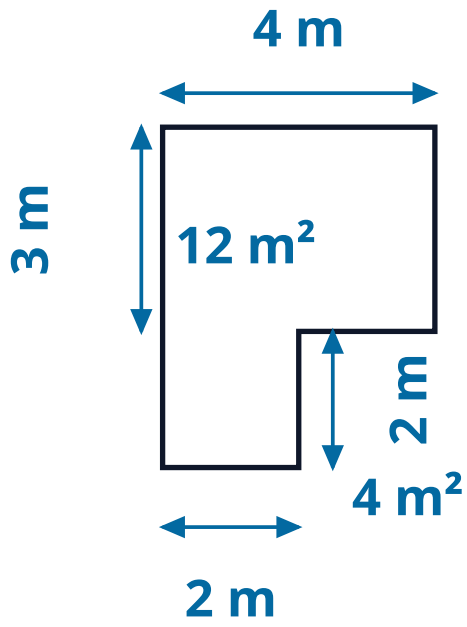
Area of a shed wall

- A square-grid estimate counts full squares and pairs the halves.
- Eight full squares and four half squares estimate 10 square units.
- A rectangle 5 metres by 4 metres has area 5 times 4, which equals 20 square metres.
- A triangle of base 4 metres and height 2 metres has 4 times 2 equals 8, and half of 8 is 4 square metres.
- The shed wall adds those pieces: 20 plus 4 equals 24 square metres.



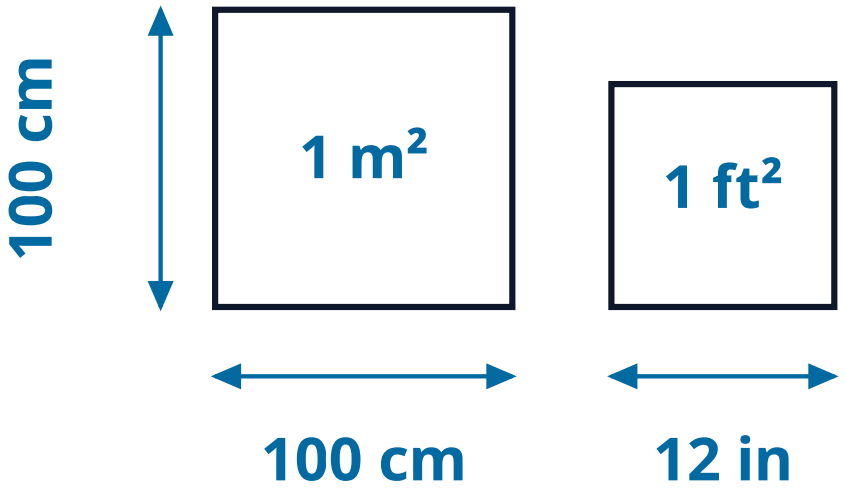
An L-shaped stock room and a bedroom

- Draw the L-shaped room and split it into two rectangles before adding the areas.
- An L-shaped stock room splits into a 4 metre by 3 metre rectangle and a 2 metre by 2 metre rectangle.
- Four times 3 equals 12 square metres.
- Two times 2 equals 4 square metres.
- Twelve plus 4 equals 16 square metres.
- A bedroom 4.8 metres by 3.5 metres splits 3.5 into 3 and 0.5.
- Partial products give 4.8 times 3 equals 14.4, and 4.8 times 0.5 equals 2.4.
- Adding 14.4 and 2.4 equals 16.8 square metres.



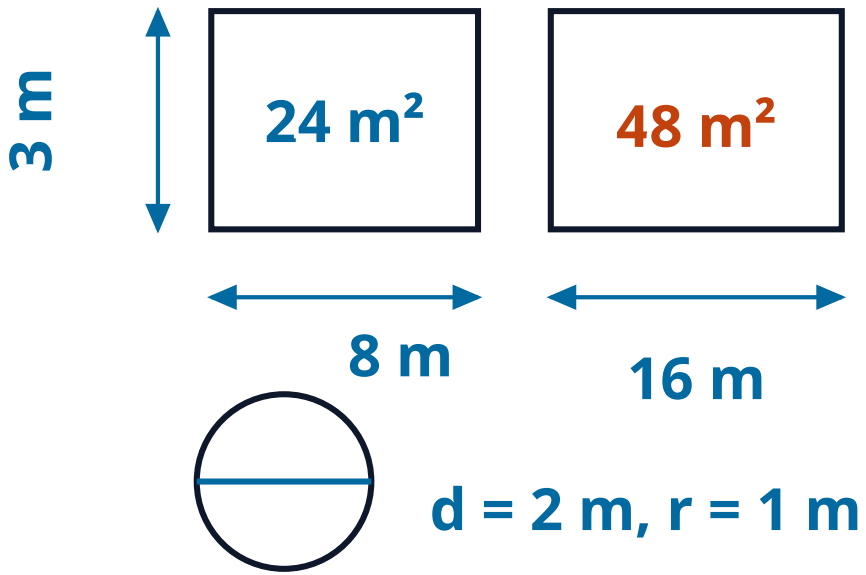
Square units on the order

- The symbol m2 means square metres and cm2 means square centimetres.
- One square metre is a 100 centimetre by 100 centimetre square, so 100 times 100 equals 10 000 square centimetres.
- A patch of 2.5 square metres equals 25 000 square centimetres.
- A patch of 0.4 square metres equals 4000 square centimetres.
- The symbol ft2 means square feet and in2 means square inches.
- One square foot equals 144 square inches, and 3 square feet equal 432 square inches.



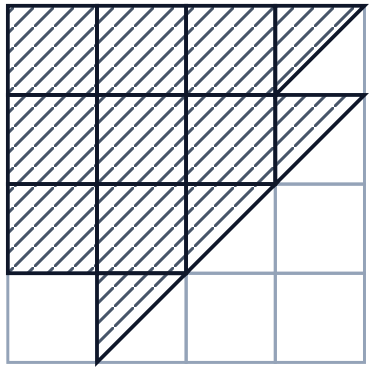
Doubling sides and a round rug

- A rectangle 8 metres by 3 metres has area 24 square metres and perimeter 22 metres, because 2 times (8 plus 3) equals 22.
- Doubling only the length makes 16 by 3.
- Multiplying 16 by 3 equals 48 square metres.
- The new perimeter is 2 times (16 plus 3).
- Sixteen plus 3 equals 19, and 2 times 19 equals 38 metres.
- Doubling both sides makes 16 by 6.
- Multiplying 16 by 6 equals 96, which is 4 times 24.
- A round rug with diameter 2 metres has radius 1 metre.
- A = πr^2 = 3.14 times 1 times 1, which is 3.14 square metres.



Cover check

- Find the triangle area for base 4 metres and height 2 metres, and the shed total of 24 square metres.
- Rewrite 1 square metre in square centimetres and say where the factor 10 000 comes from.



8 full + 4 halves = 10

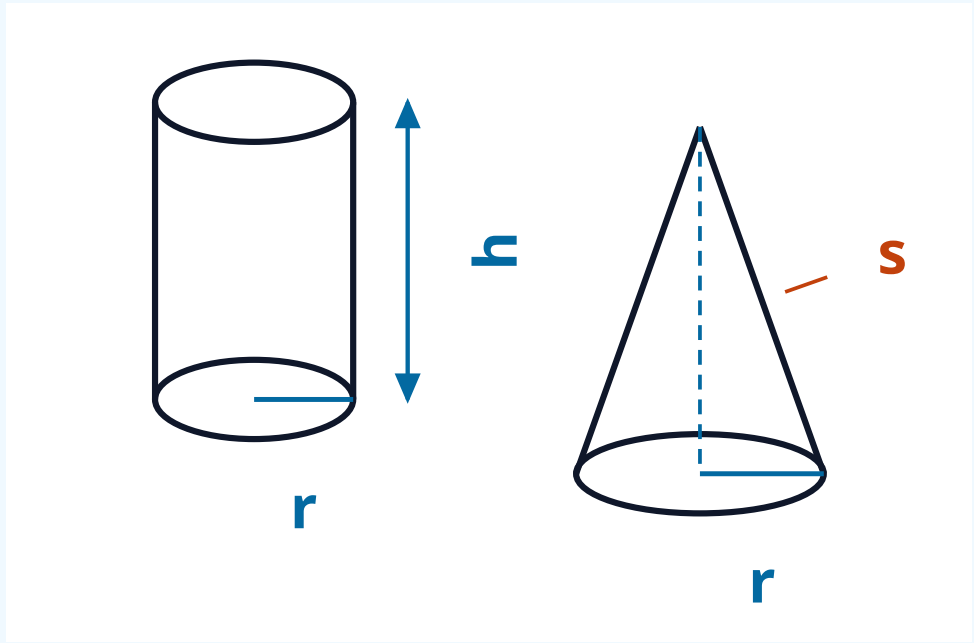
Mathematics 10-3

Unit M: Measurement in SI and imperial

Surface area of solids

Surface area in sheet metal work

- A duct fabricator orders metal for a right cylinder, and a hopper builder orders metal for a right cone.
- You order the metal that covers the outside.
- That cover is the surface area, including the ends when the formula counts the ends.



Cylinder and cone formulas

- Cylinder surface area equals $2\pi r^2$ plus $2\pi rh$.
- The letter r stands for radius, h for height, and pi is taken as 3.14.
- The two circular bases use $2\pi r^2$.
- The lateral face is a rectangle whose width is the circumference $2\pi r$ and whose height is h.
- Cone surface area equals πr^2 plus πrs.
- The letter s stands for slant height, the sloping distance along the side of the cone.



Key terms

surface area

The total cover of the outside faces of a solid, measured in square units. (SA)

slant height

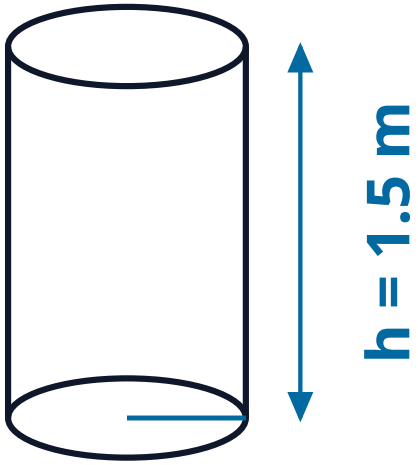
The distance along the sloping side of a right cone, from the base rim to the apex. The letter s stands for it. (s)

radius

Half the diameter. Cylinder and cone formulas in this lesson take the radius, written r. (r)

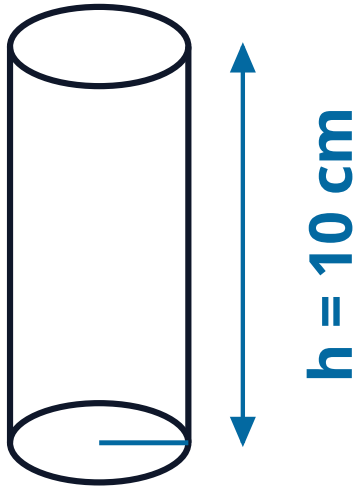
A duct with radius 0.2 metres

- The duct diameter is 0.4 metres, so the radius is half of that, 0.2 metres.
- The height is 1.5 metres and pi is 3.14.
- The two bases are 2 times 3.14 times 0.04, which equals 0.2512 square metres, because 0.2 times 0.2 equals 0.04.
- The lateral area starts with 2 times 3.14 times 0.2, which equals 1.256.
- Then 1.256 times 1.5 equals 1.884 square metres.
- Add 0.2512 and 1.884 to get 2.1352 square metres.



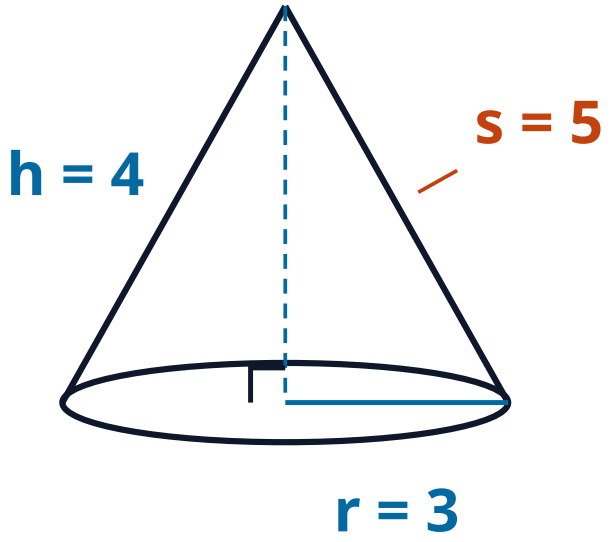
The small cylinder in centimetres

- The small cylinder has radius 2 centimetres and height 10 centimetres.
- The radius squared is 2 times 2, which equals 4.
- Two bases: 2 times 3.14 times 4 equals 25.12 square centimetres.
- The lateral face starts with 2 times 3.14, which equals 6.28.
- Then 6.28 times 2 equals 12.56, and 12.56 times 10 equals 125.6 square centimetres.
- Add 25.12 and 125.6 to get 150.72 square centimetres.



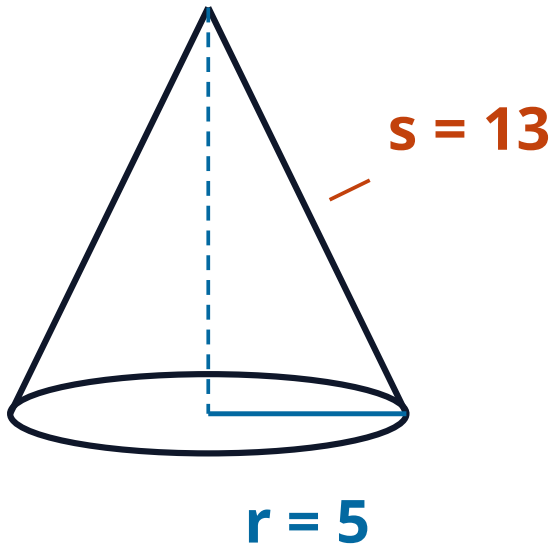
A hopper with a 3-4-5 slant

- A right cone with radius 3 and height 4 has slant height 5.
- Three squared is 9 and four squared is 16.
- Nine plus 16 equals 25, which is 5 squared.
- The surface area is πr^2 plus $\pi r s$.
- That is 9 pi plus 15 pi, which is 24 pi.
- With pi taken as 3.14, 24 times 3.14 equals 75.36 square units.



A larger cone and a sense check

- The base uses 5 times 5, which equals 25, so that part is 25π.
- The lateral face uses 5 times 13, which equals 65, so that part is 65π.
- Adding 25 and 65 equals 90, so the surface area is 90π.
- Multiplying 90 by 3.14 equals 282.6 square units.
- A sensible total is larger than one base alone.
- The duct total 2.1352 square metres is larger than one base of 0.1256 square metres.



Metal-order check

- State the radius you would substitute for a duct of diameter 0.4 metres, and the surface area 2.1352 square metres.
- State the slant you would use for radius 3 and vertical height 4, and the surface area 75.36 square units.

